DOCUMENT RESUME

ED 219 281 SE 038 788

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TITLE	Energy Storage. Teachers Guide. Science Activities in Energy.
INSTITUTION	Oak Ridge Associated Universities, Tenn.
SPONS AGENCY	Department of Energy, Washington, D.C. Office of Energy Research.
REPORT NO	DOE/NBB-0003
PUB DATE	May 82
CONTRACT	DE-AC05-76OR00033
NOTE	40p.; For related documents, See ED 170 132-133 and ED 152 529-532.
AVAILABLE FROM	U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Activity Units; Electric Batteries; *Elementary School Science; Elementary Secondary Education; *Energy; Environmental Education; Motion; *Physical Sciences; *Science Activities; Science Education; *Secondary School Science; Teaching Guides
IDENTIFIERS	*Energy Education; *Energy Storage

ABSTRACT

Included in this science activities energy package for students in grades 4-10 are 12 activities related to energy storage. Each activity is outlined on the front and back of a single sheet and is introduced by a key question. Most of the activities can be completed in the classroom with materials readily available in any community. Among the questions introducing activities are: (1) Will water which is twice as high fall out of a container twice as far? (2) Which has more energy: one teaspoon of alcohol or one teaspoon of alcohol gel? (3) How far can a balloon rocket go on compressed air in one full balloon? (4) Will flashlight batteries that are twice as large last twice as long? (5) How much longer does a C-size battery last when it is turned on-and-off compared to continuous use? (6) Will rye flour cause a bigger boom than wheat flour? (7) Will a flywheel that goes twice as fast go twice as long? (8) Will a flywheel made of 3/4 inch plywood spin 3 times longer than one made of 1/4 inch plywood? and (9) Will a spool go twice as far if its rubber band motor has twice as many turns? (JN)

Science Activities in Energy

Science Activities in Energy, a series of simple, concrete, revealing experiments, was developed especially for students in the fourth through tenth grades.

The purpose of the series is to illustrate principles and problems related to various forms of energy and their development, use, and conservation.

More importantly, *Science Activities in Energy* was designed to help you directly involve students in exploring intriguing scientific questions and in making discoveries on their own.

You don't need to be an expert in science to use these materials. In fact, many of the activities use art, economics, arithmetic , and other skills and disciplines. Since the series stresses investigation and exploration, you are not expected to know the "right" answer to every question.

Most activities in the series can be conducted in the classroom, using materials readily available in any home or school. A few activities require materials purchased from a local or national supplier. The series' developers have made a concerted effort to design activities which use the same materials or materials that can be saved for use in other units.

Each activity begins with a question. At the beginning of the activity, try to get your students to predict the outcomes, even if they lack experience or knowledge to justify their predictions. Urge them to guess! This helps them to become more interested and involved in the activity.

When working on answering a question, each student (or the class as a group) follows the instructions which lead him or her through the activity. This kind of direct participation leads students to other questions—some of which are suggested on the activities and others they generate themselves. The activities encourage exploration by the experimenters on their own.

The series' developers have purposely used metric measurements throughout the experiments. They believe that this will be part of the learning process for many young people and also for some adults.

Each activity is outlined on a single sheet. The sheets can be photocopied for distribution or easily projected on a screen or a wall.

Published: May 1982
Mary Lynn Jacobs, editor

Energy Storage 1

Question
Will water which is twice as high fall out of a container twice as far?

Time
40 to 50 minutes.

Objective
The student will measure how far the water falls out of the can, indicating which depth of water has the greatest pressure.

Process Skills
Hypothesizing and observing.

Materials & Procedure Clues
Since the size of a hole will affect how far water falls from a can, make sure that both holes in a can are the same size. Be sure the clay plugs the hole so the can doesn't leak. The students should hold onto the cans so the cans don't move as they pull their fingers away from the hole. Conduct the experiment on a flat pan or the floor. Keep a mop handy!

Concept
The potential energy of water increases as the water level rises.

Background
Stored water, such as snow in the mountains or water behind a dam, has potential energy The amount of energy stored in the water is directly proportional to the distance the water falls when it is released

Electric utilities sometimes store excess electrical power they produce by using electricity to pump water to an elevated storage lake When electrical power is needed, stored water from the lake is released to turn turbine-generators

When water is released from the can in the experiment, the path it takes is determined by two motions — gravity and water pressure Gravity causes water behind a dam to fall downward when the water is released, it causes water in this experiment to fall sideways out of the hole in the can

Since the water pressure is not constant in the experiment (the water level in the can drops continuously), the best way to compare the trial results is to mark the position of the water when it first hits the table

Precautions
Do not conduct the experiment near electrical outlets Be sure the cans do not have sharp edges Be careful on wet, slippery floors

Results
The water from the higher hole will fall out three to four times as far as the water from the lower hole Note that the higher hole in the can is only twice as high as the [illegible]r hole

Strategies
Before: What are the properties or characteristics of water? Discuss how dams and turbines are used to make electricity. Predict what the stream of water will do when the students remove their fingers from the holes.

After: Discuss the results What are the variables in the experiment? How could you adjust the variables to get the greatest energy output?

Energy Storage 2

Question

Which has more energy: one teaspoon of alcohol or one teaspoon of alcohol gel?

Process Skills

Hypothesizing, observing, and measuring

Time

40 to 50 minutes

Materials & Procedure Clues

If you have trouble finding calcium acetate to make the alcohol gel, substitute sterno (a commercial alcohol gel) in the experiment.

Objective

The student will make some alcohol gel and then measure how much heat it will generate compared to liquid alcohol.

Concept

It is possible to change a liquid fuel into a solid fuel which is more convenient and can be easily stored

Background

Changing liquid alcohol to a solid form is similar to making a gelatin dessert Water is solidified in making a gelatin dessert Alcohol is solidified in making an alcohol gel

When the alcohol is mixed with calcium acetate, it forms a colloid — a suspension of small alcohol droplets The calcium acetate prevents the droplets from joining together to form liquid alcohol The stable droplets behave like small pebbles, making the mixture a solid one

Since the process is a physical process — changing alcohol from a liquid to a solid — and not a chemical one, the energy content of the fuel is not altered However, since calcium acetate burns, the alcohol gel may produce slightly more heat than liquid alcohol

Precautions

Be careful not to inhale fumes from the gel
Be careful in using flames to test the energy output

Strategies

Before: Have students make the gel first They should discuss or research information on gels and their uses

After: Which form of alcohol has more energy? What are the hazards of using gels? Of liquids? Discuss

Results

The alcohol gel has slightly more energy than the liquid alcohol

Energy Storage 3

Question
How far can a balloon rocket go on the compressed air in one full balloon?

Time
40 to 50 minutes

Objective
The student will build a small, compressed-air rocket and determine how far it travels

Process Skills
Observing, measuring, and organizing data.

Materials & Procedure Clues
Check to see that the fish line remains taut before starting experiment. Be sure the balloon is tightly attached to the straw.

Concept
Energy can be stored in the form of compressed air for use when needed

Background
Potential energy in the form of compressed air is stored in the balloon. The energy used to compress the air comes from the students' lungs

The compressed-air rocket works on the following principle for every action there is an equal but opposite reaction The air leaves the balloon at a certain speed in one direction, propelling the rocket at the same speed in the opposite direction

Commercial jet airplanes work on the same principle

Precautions
Arrange the students in the classroom so they do not hit each other's fish lines or balloons.

Teachers should drill holes in the corks

Results
A small, six-inch balloon should go about eight meters. depending on how much air is compressed and the amount of friction between the fish line and the straw

Strategies
Before Talk about jet airplanes and how they work Discuss precautions that need to be taken to be sure the compressed-air rocket works

After Which rocket went the farthest? How can the students modify it to get greater distance or efficiency?

Energy Storage 4

Question
Will flashlight batteries that are twice as large last twice as long?

Time
40 to 55 minutes.

Objective
The student will determine the effectiveness of various batteries in running a motor.

Process Skills
Observing and measuring.

Materials & Procedure Clues
Be sure that the motors will work with the batteries

We've used the term "battery" instead of "cell" because that usage is more common for the age level to which these activities are directed

Concept
A battery will last longer if the demand on it is less than what it is capable of supplying.

Background
Batteries are composed of a variety of chemical materials. When a motor is connected to the terminals of a battery, the materials in the battery react

Compared to a smaller battery, a larger battery has a greater amount of materials inside of it. When connected to the same motor, a larger battery does not use its chemical supply as rapidly as a smaller battery. A battery whose diameter is twice that of another battery and is the same size in length actually contains four times the material of the smaller battery.

Precautions
Be careful when using a soldering iron

Results
The D battery will last approximately twice as long as the C battery

Strategies
Before. Have the students predict how long each battery will last.

After. Have the students try to explain the results Calculate the amount of material in each battery and compare it to how long it lasted. Discuss if the batteries are worth their various prices

Energy Storage 5

Question

How much longer does a C-size battery last when it is used on-and-off compared to continuous use?

Time

40 to 50 minutes

Objective

Students will compare the life of a battery used on-and-off versus continuously.

Process Skills

Observing, measuring, organizing, and replicating data

Materials & Procedure Clues

Try to have something for the students to do while waiting during the five-minute recharging period Students may need help setting up the tables for recording data We've used the term "battery" instead of "cell" because that usage is more common for the age level to which these activities are directed.

Concept

A battery lasts longer if it is given a chance to rest between uses

Background

When a battery runs continuously under heavy use, the chemical reaction takes place rapidly The surface of the metal inside of the battery becomes covered with by-products of the reaction, decreasing the efficiency of the battery and its ability to produce electricity.

When a battery is able to rest between uses, some of the by-products coating the metal dissolve Once again, the metal surface is exposed to the chemicals in the battery, resulting in a more complete reaction.

Precautions

The meter is fragile so it should be treated with care Check the wiring circuits carefully

Results

The battery lasts 25 to 50 percent longer when used on-and-off compared to continuous use

Strategies

Before. Have the students predict what will happen

After Discuss the results

Energy Storage 6

Question
Will rye flour cause a bigger boom than wheat flour?

Time
15 minutes for each explosion setup.

Objective
The student will observe the results of exploding various types of flour and how it relates to their potential energy.

Process Skills
Observing and replicating.

Materials & Procedure Clues
Try the experiment ahead of time to be sure you know what will happen. The plastic cover should not hurt anyone or anything, but you need to know where and how far it will go. You also need to know how loud it will be. Young students may be frightened.

Concept
The energy of sunlight is stored by plants mainly as starch and oil. In a finely divided state, these chemicals rapidly combine with oxygen and explode.

Background
Plants store energy in different chemical forms. Potatoes store energy primarily as starch, while trees store energy as cellulose. Seeds from hardy grasses, such as wheat and rye, store energy as starch and oil.

The energy content of wheat and rye is about the same. However, the finer the seeds are ground, the easier and faster they burn.

In the coffee can, each small particle of flour is mixed and surrounded by air. The rapid burning process raises the temperature and pressure inside of the can, causing an explosion. The sudden expansion of the air lifts the lid and also causes the noise

Precautions
Be careful of scaring the children. Warn students about doing this experiment at home because of fire danger

Results
Both flours will produce similar results

Strategies
Before: Have the students predict what will happen What causes an explosion?

After How does this relate to grain or dust explosions?

Energy Storage 7

Question

Will a flywheel that goes twice as fast go twice as long?

Time

45 to 50 minutes

Objective

The students will measure how long a flywheel will continue to turn at various rotation speeds.

Process Skills

Hypothesizing, controlling variables, and observing.

Materials & Procedure Clues

Check the flywheels to be sure they work properly.

Let students practice using the strobe wheel, so they see what they should look for

Be sure the strobe is working properly

Concept

The energy stored in the flywheel is proportional to the square of its speed (disregarding friction). For example, a flywheel going twice as fast as another one has four times the stored energy of the other.

Background

Flywheels have been used for many years to store relatively small amounts of energy. For example, a flywheel is used to store energy in automobile and steam engines.

Without friction, a flywheel moving twice as fast as another one has four times the stored energy. Typically, a flywheel is mounted on ball bearings in order to minimize friction

The amount of stored energy a flywheel contains can be measured by how long it rotates

One of the uses of a strobe is to measure the speed of rapidly moving objects.

Pay attention to a wagon wheel in a Western movie, and you will see the strobe effect. The wheel will appear to rotate forward, stop, and rotate backward as the speed of the wagon changes

Precautions

Be careful of splinters on the flywheels

Strategies

Before. Predict what will happen.

After Explain the principle of a flywheel Discuss how much more energy a moving object has as its speed increases. As an example, how much more difficult is it to stop a speeding car than one moving slowly?

Results

The flywheel going twice as fast should go about three times as long. The results will ... ys be more than twice and sometimes ... uch as four times longer

Energy Storage 8

Question

Will a flywheel made of 3/4" plywood spin 3 times longer than one made of 1/4" plywood?

Time

45 to 50 minutes to conduct the experiment. One hour to make the flywheels.

Objective

The student will measure whether the heavier or lighter flywheel spins longer.

Process Skills

Hypothesizing, controlling variables, and observing.

Materials & Procedure Clues

Make the flywheels ahead of time Make sure the flywheel and the strobe are working properly.

Concept

The more massive the flywheel is the more kinetic energy it possesses.

Background

To compare the energy content of two flywheels, it is essential that their speeds ·e exactly the same The strobe is a device that makes it possible to accurately compare speeds

There is a direct relationship between the weight of a flywheel and the energy it possesses. The more energy a flywheel possesses, the longer it will spin The flywheel stops when all of its energy has been converted to heat caused by friction.

Precautions

Be careful of splinters on a spinning flywheel

Strategies

Before: Have students predict what will happen

After: What happened? What variables were controlled and manipulated? How are flywheels used today?

Results

The flywheel made of 3/4" plywood will spin about two to three times longer than one made f 1/4" plywood

Energy Storage 9

Question
The Great FLYWHEEL CONTEST!

Process Skills
Controlling variables and observing

Time
If students construct the flywheels at home, the contest should take about 30 minutes

Objective
The student will try to control all necessary variables and manipulate others to get a flywheel to rotate longer than other students'

Materials & Procedure Clues
Have the students plan their flywheels on paper before making them Check the plan for ideas and precautions. Set some limits so students do not spend inordinate amounts of money on the contest.

Concept
The shape and distribution of the mass of the flywheels make a great deal of difference in the energy they can store.

Background
The shape, balance, and distribution of materials of a flywheel determine how long it will rotate Friction and air resistance also affect its rotation

The object in constructing a flywheel is to increase its inertia as much as possible without changing its weight or balance Therefore, the heavier a flywheel is at its rim, the more energy it will have when it is rotating

See *Energy Storage, Activities 8* and *9* for information on flywheels and strobes

Precautions
Students should use caution in building the flywheels

Strategies
Before Develop a list of variables that might affect a flywheel's energy

After. Why did the winning flywheel win? What were the problems or limiting variables in the losing flywheels?

Results
The results will vary depending on the design of the flywheel The flywheel that is well-balanced and has most of its weight as far from the center as possible ...uld rotate the longest

Energy Storage 10

Question

Will a spool go twice as far if its rubber band motor has twice as many turns?

Time

40 to 50 minutes

Objective

The student will build and operate a rubber band-powered spool motor and compare the number of turns of the rubber band with the distance the spool travels

Process Skills

Observing and measuring variables

Materials & Procedure Clues

Have the students test the motor to see how it works, how to make it move, and what direction and speed it goes Be sure the rubber bands are of good quality and not too old Check for chips in the spools or buttons that will tend to make the motor catch or stick The buttonhole may have to be enlarged for the rubber band

Concept

A twisted rubber band contains stored energy that can be used

Background

Rubber has some very interesting properties Most substances expand when heated, but rubber contracts When rubber is stretched and then released, it returns to its original length Therefore, it is possible to store mechanical energy in the form of twisted rubber bands Twisting a rubber band is analogous to stretching it

Since a rubber band does not follow Hooke's Law*, it is difficult to predict how a rubber band will behave Also, as a rubber band is being twisted, it gets harder to turn Therefore, more energy is being stored at the end of the twisting process than at the beginning

The best way to guess how a rubber band will behave is to experiment with it

*Hooke's Law says that the stretch of a spring is exactly proportional to the force applied

Precautions

Burn the matchheads before the experiment, so students are not tempted to light them during the class

Results

The spool will go farther with twice as many turns, but the results will vary depending on many factors

Strategies

Before — Have students check the spools to be sure they work Ask the students to predict what will happen

After — What happened? What are the variables? How can each be controlled or manipulated? Graph your results to find the most typical response

Energy Storage 11

Question
How hot will a mixture of water and ice get when it's heated?

Time
45 minutes

Objective
The student will observe that the temperature of the water remains constant as long as ice remains in the container

Process Skills
Hypothesizing, observing, and measuring

Materials & Procedure Clues
Be sure the coat hanger frame is sturdy so the glass will not fall Caution the students to stir the water very carefully with the wooden pencil or the thermometer will break

Concept
Changing the physical state of a substance (for example, from solid to liquid) requires energy

Background
Changing the physical state of a substance requires adding or taking away heat Changing ice to water or changing water to steam requires heat When steam changes to water, it must give up heat When water changes to ice, it also must give up heat Temperature measures the heat in a substance, but it does not measure the total amount of energy a material may have

A mixture of ice and water will remain 0°C as long as there is ice in the mixture and the mixture is well stirred As long as ice is added to the can, the heat will be used to melt the ice instead of raising the temperature of the mixture

Precautions
Care should be exercised when using fire Do not stir too hard with the wooden pencil Be careful for the water may be hot at the end of the experiment

Strategies
Before Ask the students to predict the results and record their predictions on the chalkboard

After Why did the temperature do what it did? Where is the energy going? Where is the energy stored?

Results
The temperature stays at about 0°C until the ice is melted Then, it begins to rise at a linear rate

Energy Storage 12

Question

Will dropping a weight from two meters produce twice the dent as dropping it from one meter?

Time

45 minutes

Objective

The student will observe how height relates to the depth of a dent produced when an object is released

Process Skills

Hypothesizing, measuring, and observing

Materials & Procedure Clues

Be sure the students smooth off the top of the damp sand each time Let the students practice dropping the weight so it hits the target The sand should not be too wet, just damp enough to be shaped

Concept

The potential energy of an object is equal to the work it takes to raise it to its present height When an object falls back to its original position, it releases its potential energy as kinetic energy — the energy of motion

Background

The potential energy of a falling object depends on how much work was used to raise it Since it takes twice as much work to raise an object two meters as it does one meter, the object will have twice as much potential energy

When an object is dropped, the higher the object is, the faster it will be going when it stikes the sand

The depth of the hole is a measure of the energy the object has when it hits However, the sand tends to compress when the object hits, and therefore, it doesn't present uniform resistance to the entry of the object For this reason, you cannot expect a perfect relationship between the energy of the object and the depth of the hole

Precautions

Be careful the students do not fall if they stand on a chair or table to drop the object

Results

The dent made is not quite twice as deep for twice the height, but close to it

Strategies

Before Have the students predict the outcome

After Where is the energy in the system? Where is the potential and kinetic energy? Is there a limit to height versus dent relationship?

As the developer of *Science Activities in Energy*, Oak Ridge Associated Universities is anxious to learn how you and your students use the activities, what variations you develop, and any results you find extraordinary.

Please let us know your reactions to the activities. Also, feel free to ask for information on any energy-related topic.

Prepared by: Oak Ridge Associated Universities,
Oak Ridge, TN 37830, under Contract No. DE-AC05-76OR00033.

Prepared for: U.S. Department of Energy
Office of Energy Research, Washington, D.C. 20585

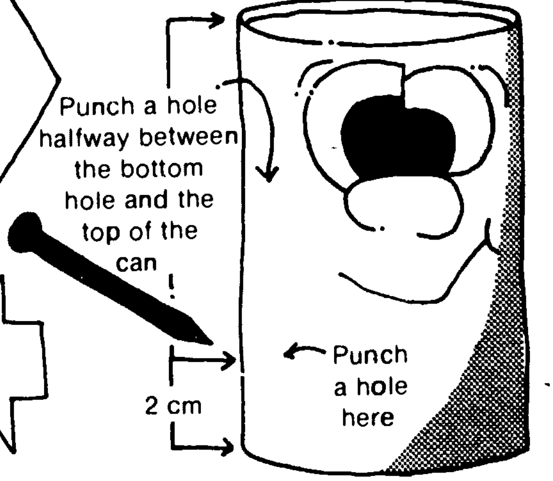
WILL WATER WHICH IS TWICE AS HIGH FALL OUT OF A CONTAINER TWICE AS FAR?

1

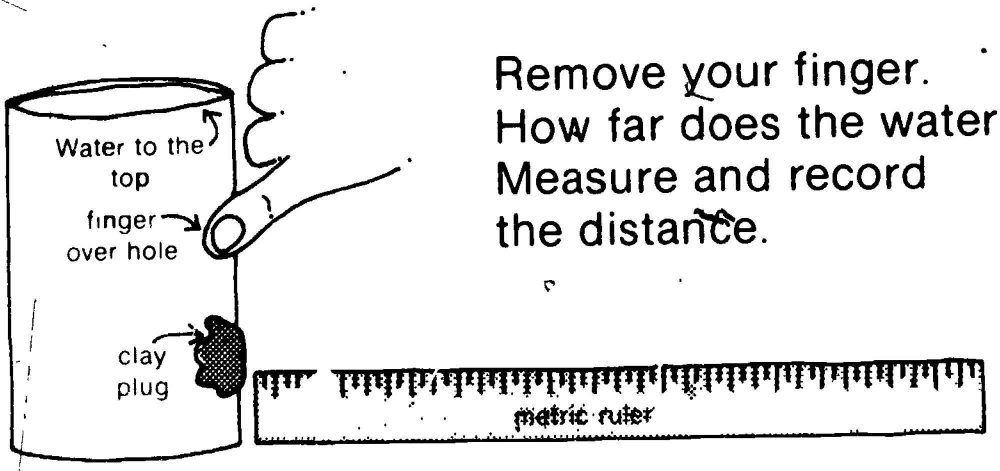
MATERIALS:

Tall juice can
Teacher's Discretion Hammer; eightpenny nail
Metric ruler
Modeling clay

Prepare your tin can.

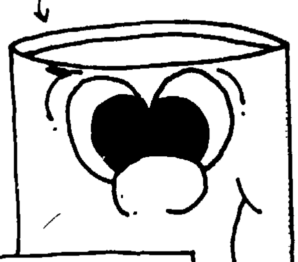


Plug the bottom hole with clay. Place your finger over the other hole and fill the can to the top with water.



Remove your finger.
How far does the water go?
Measure and record the distance.

Now, plug the top hole with clay. Remove the clay plug from the bottom hole. Place your finger over the bottom hole and repeat the experiment.



	distance measured
top hole	
bottom hole	

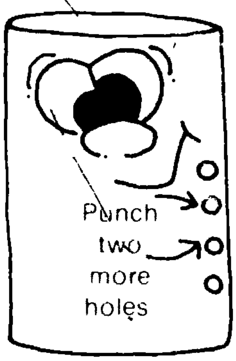
Summary question:

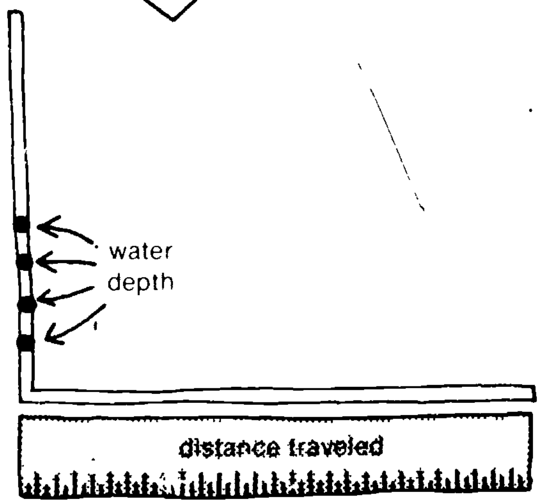
Does the water falling from the top hole have less energy than water falling from the bottom hole?

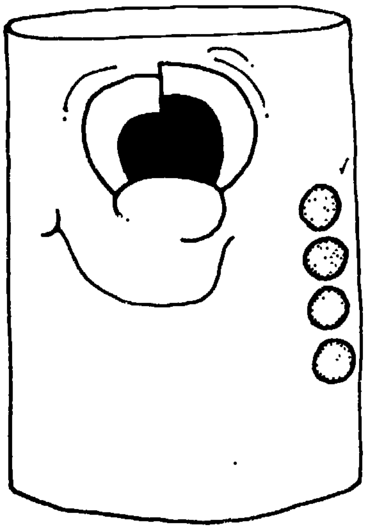
OTHER IDEAS TO EXPLORE:

Punch two more holes in between the two already punched. Repeat the experiment, measuring the distance the water travels.

Plot a graph showing water depth and the distance water travels. What kind of line do you expect to get on the graph?



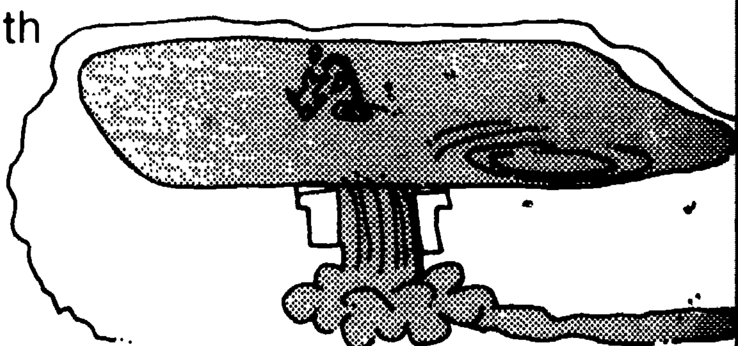




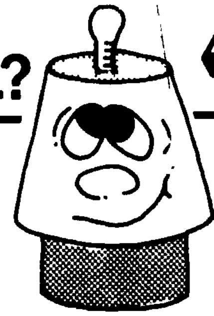
Make the holes twice as large using a nail with twice the diameter (sixteenpenny). How do the results compare with your first experiment?

Can you get more electricity from a hydroelectric plant by adding more turbine-generators?

Which turbine will be driven with greater force: one at the bottom of a 100-foot dam holding back a large lake or a 200-foot dam holding back a small lake?



WHICH HAS MORE ENERGY: 1 TEASPOON OF ALCOHOL OR 1 TEASPOON OF ALCOHOL GEL?

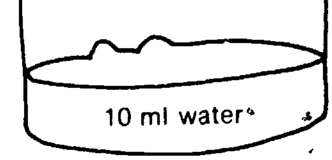


2

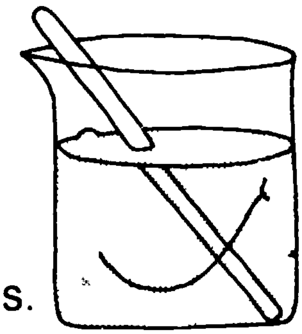
MATERIALS:

- Calcium acetate; measuring spoons
- Wood alcohol (hardware or paint stores)
- 100-ml Beaker; metric ruler
- Graduated cylinder; thermometer
- Matches; glass stirring rod
- Large tin can; styrofoam cup
- Quart jar lid (remove paper liner)
- Brick; metal coat hanger; potholder

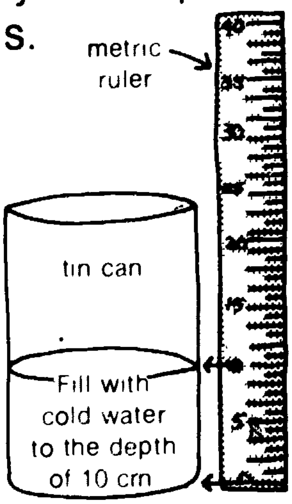
To make alcohol gel, dissolve calcium acetate in water until no more will dissolve. Some of the calcium acetate will stay on the bottom.

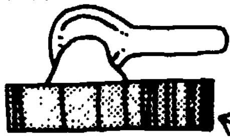


Then, add 60 ml of wood alcohol to the calcium acetate mixture. Stir and set aside until the mixture gels.

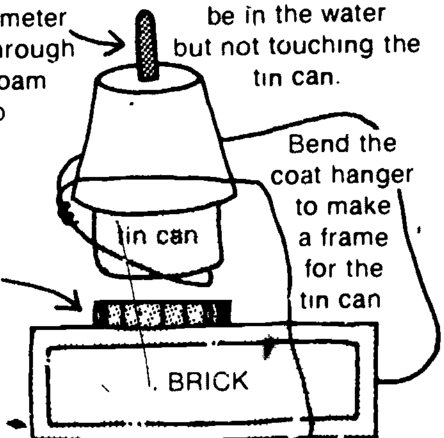


Set up your experiment like this.





WARNING: The tin can gets hot.



Measure and record the cold water temperature.

Ignite the alcohol. Measure and record the water temperature after all the alcohol has been burned.

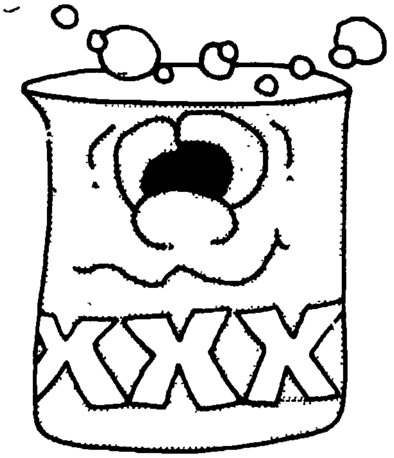
	temperature of cold water	temperature after heating	difference in temperatures
alcohol gel			
alcohol			

Pick up the hot can with a potholder and pour out the hot water. Rinse the can with cold water to cool it. Using fresh cold water, do the experiment again with one teaspoon of alcohol gel. Record your results.

Summary question:

Did you find a significant difference between the energy contents of alcohol and alcohol gel?

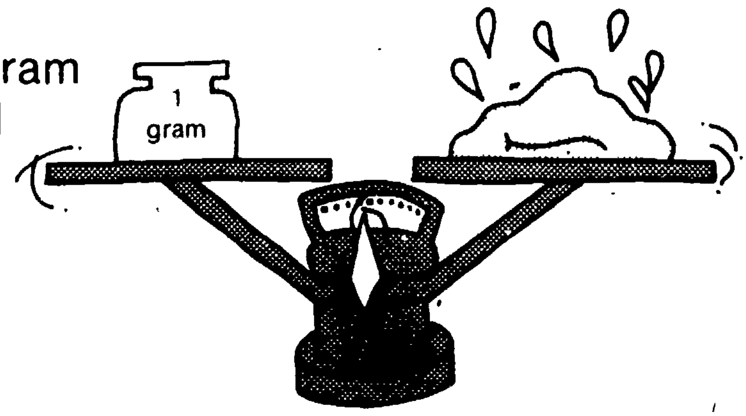
OTHER IDEAS TO EXPLORE:



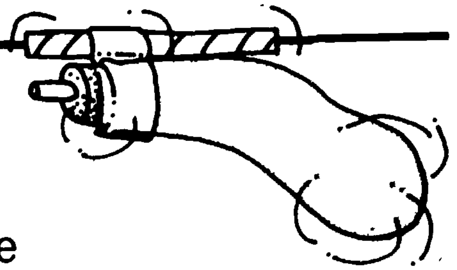
Will your alcohol gel produce more heat energy if you use grain alcohol instead of wood alcohol?

What is the advantage of storing energy as a solid compared to a liquid?

How many calories of heat are lost when one gram of alcohol gel is exposed to the air for one week?

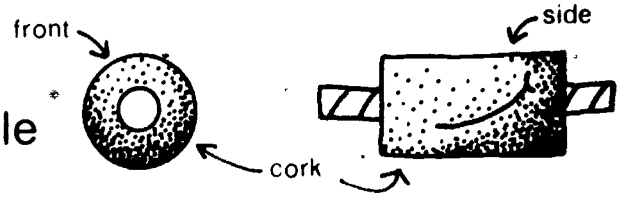


HOW FAR CAN A BALLOON ROCKET GO ON THE COMPRESSED AIR IN ONE FULL BALLOON? 3

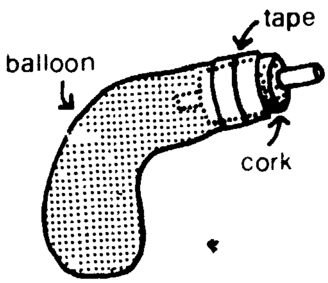


MATERIALS:

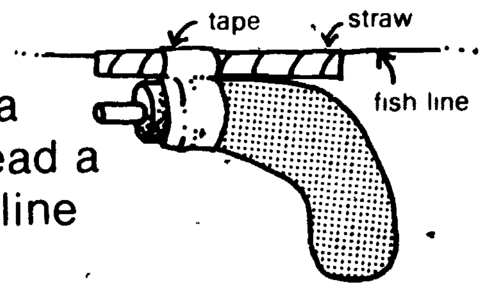
- Plastic drinking straws; glue or tape
- Long balloons; corks
- Teacher's Discretion → 3/16" Drill
- Monofilament fish line



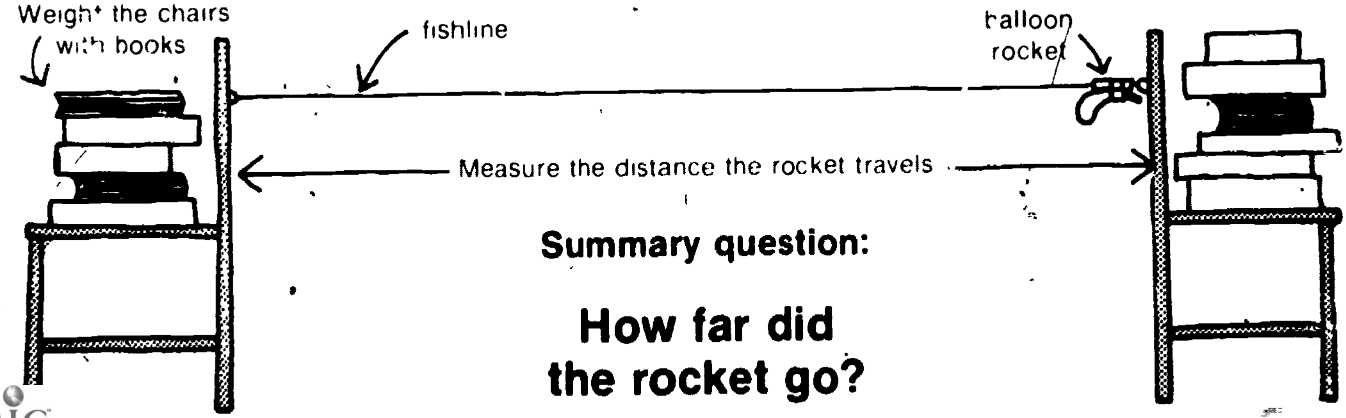
Make a balloon rocket. Drill a hole in the cork. Put a section of plastic straw through the hole. Force a balloon over the cork. Tape it in place. Make sure there aren't any air leaks!



Tape or glue the balloon to half of a plastic straw. Thread a long piece of fish line through the straw.



Stretch the fish line tightly between two chairs. Blow up the balloon through the straw in the cork. Hold the air in the balloon with your finger. Move the rocket to one chair and let go!

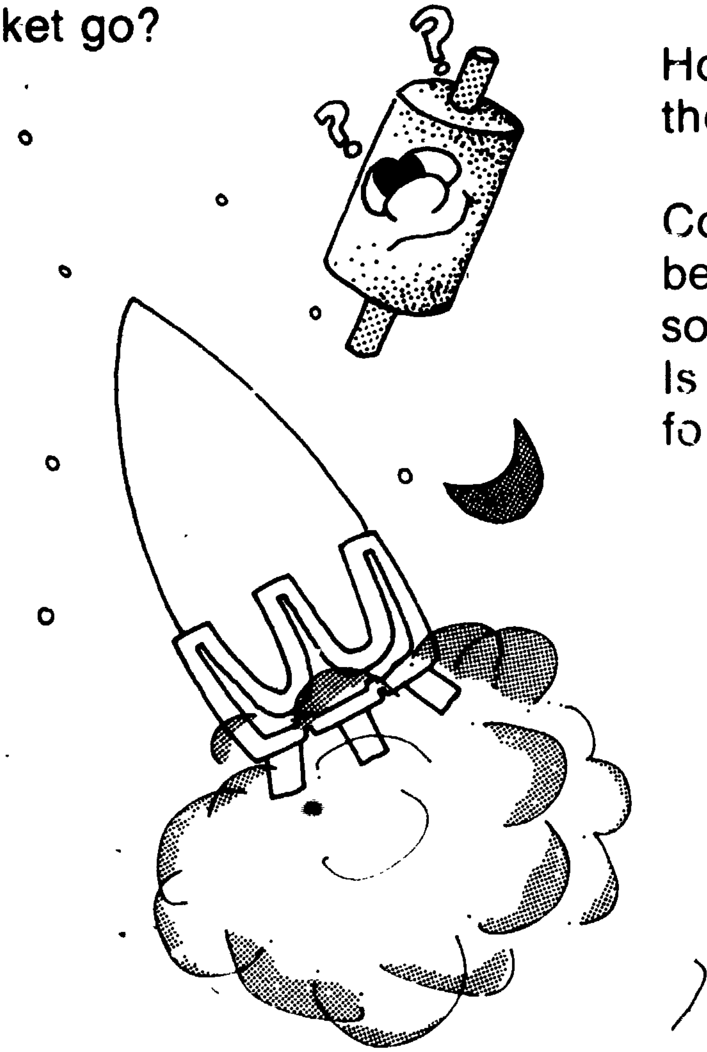


Summary question:

How far did the rocket go?

OTHER IDEAS TO EXPLORE:

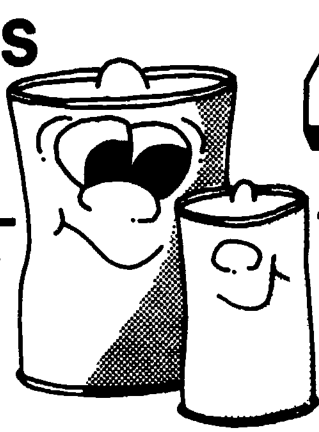
Where is the energy stored that makes the rocket go?



How can you make the rocket go farther?

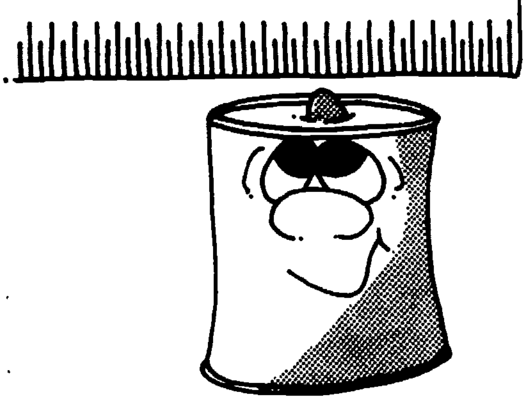
Could compressed air be used as the energy source in space travel? Is an atmosphere required for this to work?

WILL FLASHLIGHT BATTERIES THAT ARE TWICE AS LARGE LAST TWICE AS LONG?

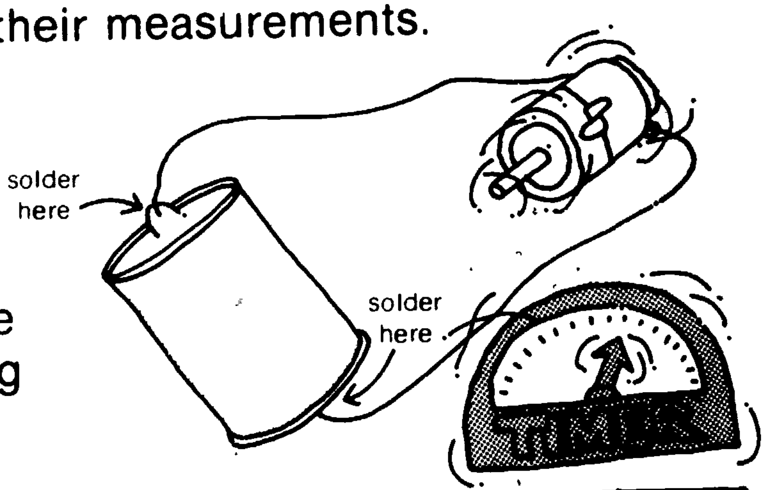


MATERIALS:

Watch with a second hand
Small motor, 1½-6 volts
Teacher's Discretion: Metric ruler; solder and soldering iron
Flashlight batteries* one each, D, C, and AA sizes



Measure the diameters and lengths of the three batteries and record their measurements.



Connect the motor to one battery and time how long the motor runs. Repeat for each battery.

battery size	diameter	length	volume	Time the motor runs	
				new	2nd day
D					
C					
AA					

Let the batteries rest one day and repeat the experiment.

*We've used the term "battery" instead of "cell" because that usage is more common for the age level to which these activities are directed.

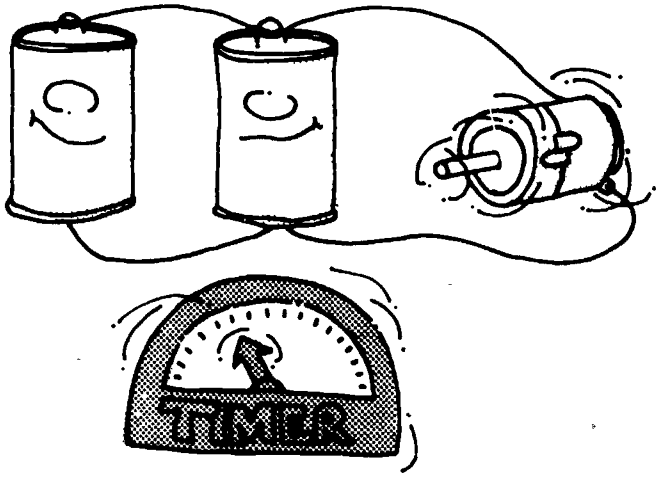
Summary question:

Are larger batteries better than smaller ones?

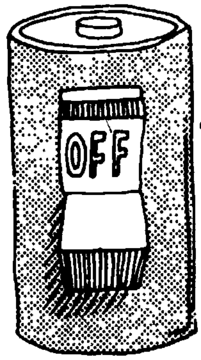
OTHER IDEAS TO EXPLORE:

When is the use of very small batteries a good idea?

Would two batteries connected in parallel last longer than if they were used one at a time?



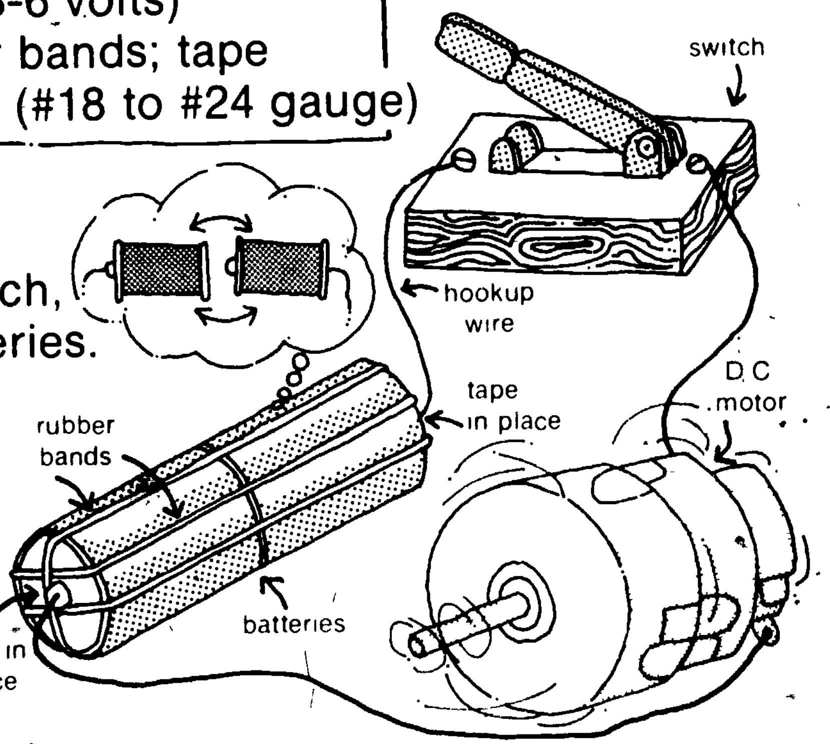
HOW MUCH LONGER DOES A C-SIZE BATTERY* LAST WHEN IT IS USED ON-AND-OFF COMPARED TO CONTINUOUS USE?



5

MATERIALS:

4 C-size Batteries (inexpensive ones)
Switch (single pole, single throw)
Small D.C. motor (3-6 volts)
Teacher's Discretion: Knife; clock; rubber bands; tape
50 cm Hookup wire (#18 to #24 gauge)



Connect the motor, switch, and two batteries in a series. The batteries must be held tightly together.

Turn the switch on for five minutes, then turn it off for one minute. Repeat until the batteries no longer have enough power to run the motor.
How long do the batteries work?

	batteries used on-and-off	batteries used continuously
time		

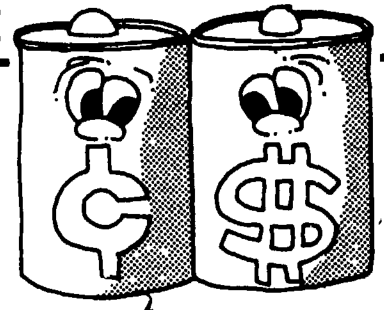
Connect the motor to two fresh C-size batteries and run them until the motor stops. How long do the batteries last?

*We've used the term "battery" instead of "cell" because that usage is more common for the age level to which these activities are directed.

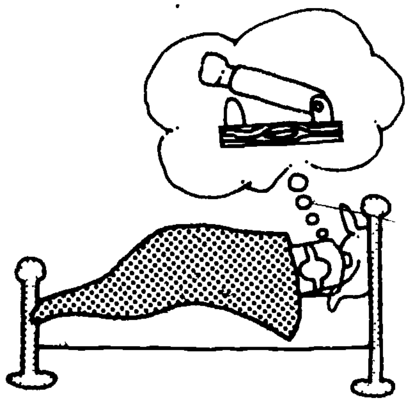
Summary question:

Does it pay to turn batteries on and off?

OTHER IDEAS TO EXPLORE:



Would you get similar results if you used more expensive batteries?



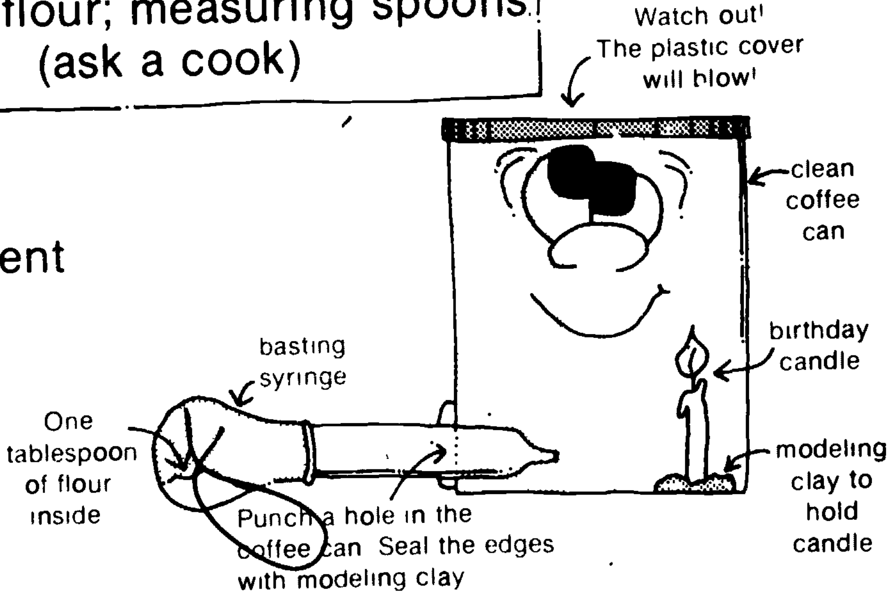
Would your results be even better if you allowed a longer resting period during the on-and-off testing?

Can you develop an automatic way of testing batteries?

WILL RYE FLOUR CAUSE A BIGGER BOOM THAN WHEAT FLOUR? 6

MATERIALS:

3 lb. Coffee can with plastic cover
Matches; birthday candles; modeling clay
White flour; rye flour; measuring spoons
Basting syringe (ask a cook)



Set up your experiment like this.

Put one tablespoon of white flour in the basting syringe.

Light the candle and put the lid on the coffee can.

Stand back! Squeeze the baster to blow flour dust in the can.
How high does the cover blow?
Record your results.

Clean the can thoroughly with water. Repeat the experiment using one tablespoon of rye flour. Record your results.

white flour ______ meters

rye flour ______ meters

Summary questions:

Which flour blows the cover higher?

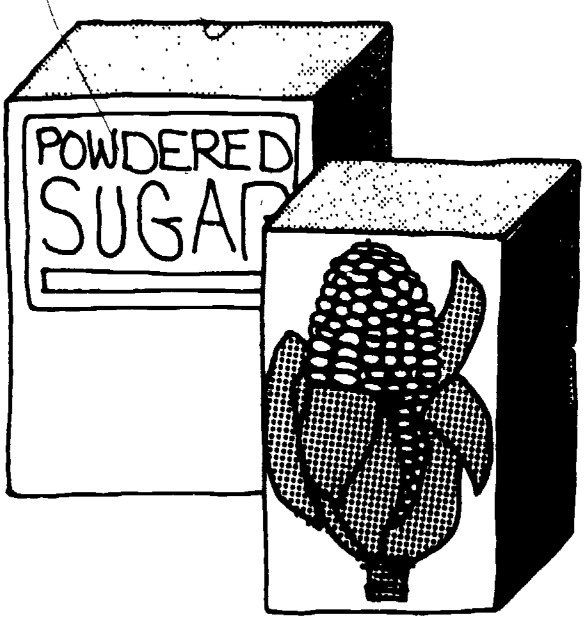
Which flour makes a louder noise?

OTHER IDEAS TO EXPLORE:

Is it easy to make
flour explode?
What does this experiment show
about the energy of flour?

Do you get a bigger explosion
if you use less flour?
More flour?

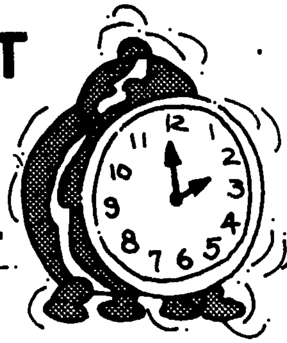
Where does the energy come from
that is stored in flour?



Try using powdered sugar
or cornstarch.

Compare your results to
those in the experiment.

WILL A FLYWHEEL THAT GOES TWICE AS FAST GO TWICE AS LONG?

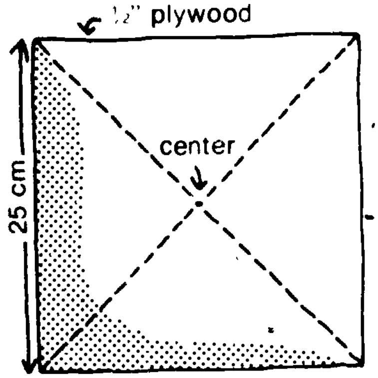


7

MATERIALS:

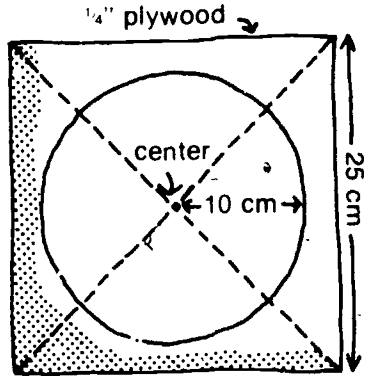
Teacher's Discretion ▶ 1 Piece ¼" plywood, 25-cm square; coping saw or jigsaw
1 Piece ½" plywood, 25-cm square; fluorescent light; tape
2 Pieces ½" plywood, 3 cm x 25 cm; protractor; felt pen
Teacher's Discretion ▶ Roller skate wheel (local roller rink throwaways); ¼" drill
1¼" Carriage bolt, 2" long, with nut and 4 washers to fit
3 #10 Bolts, 15-cm long, with nuts to fit; strobe wheels (see diagram on back)

Make a flywheel.

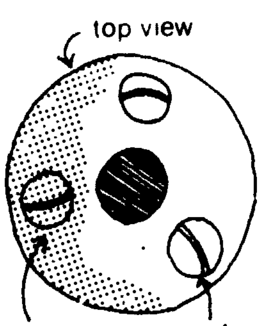


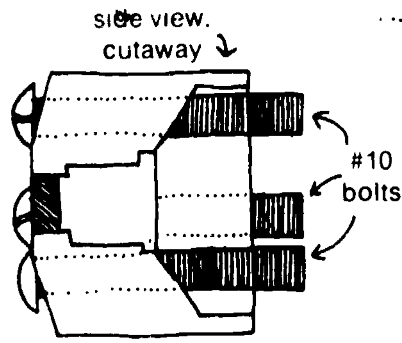
Drill ¼" holes in the centers of the plywood pieces.

Then, cut a 20-cm diameter circle from the ¼" plywood piece.

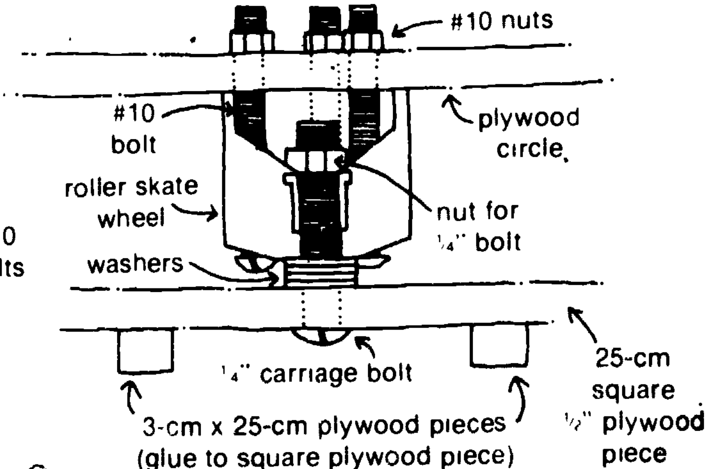


Drill three holes in the roller skate wheel as shown.



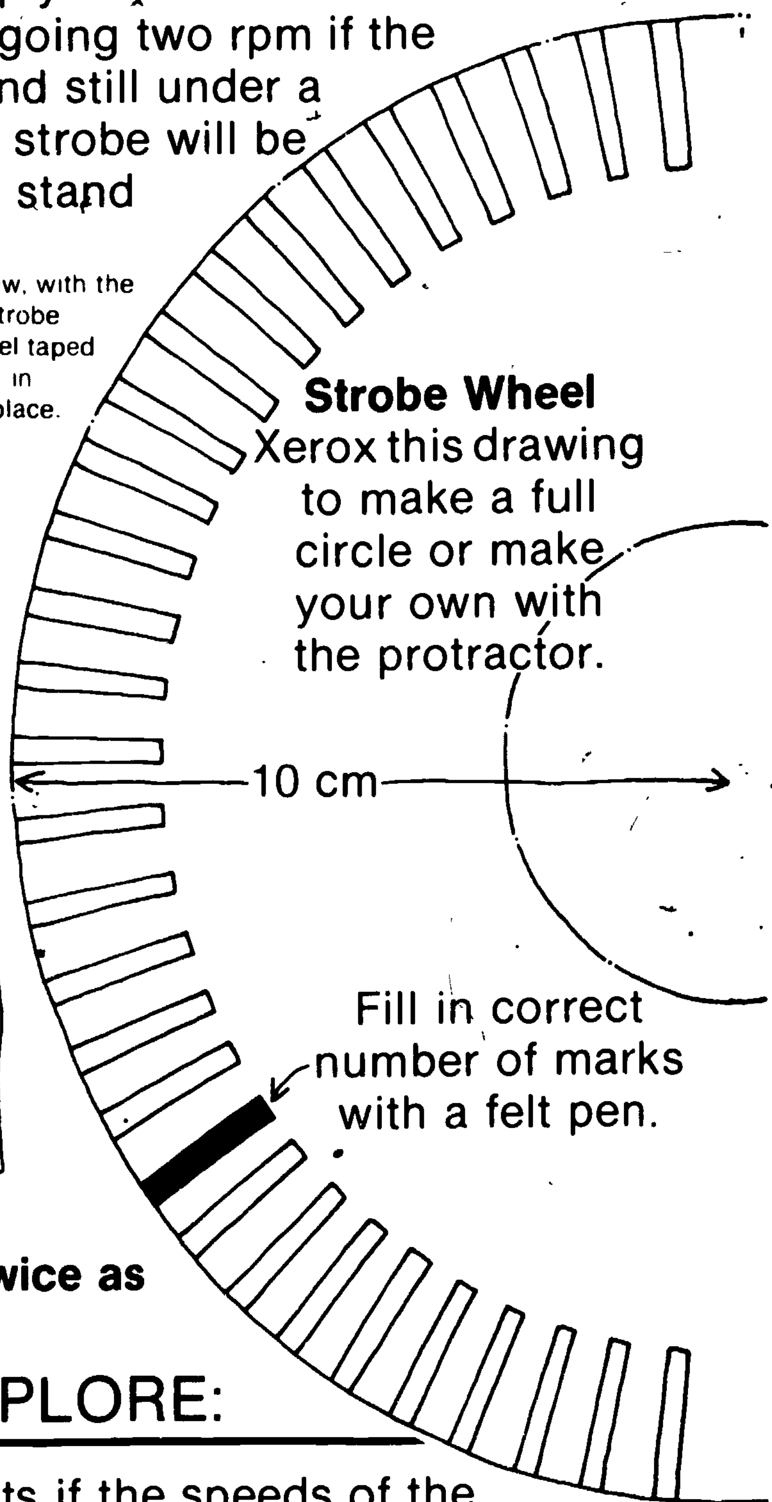


Then, assemble the flywheel. (More drilling will be required in the plywood circle.)

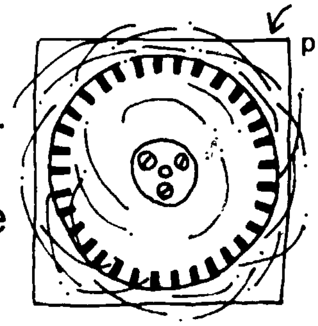


Make two strobe wheels, one with 60 marks and one with 30 marks. Follow this diagram.

Tape one strobe wheel to the plywood circle and spin it. The wheel will be going two rpm if the 60-mark strobe appears to stand still under a fluorescent light. The 30-mark strobe will be going four rpm if it appears to stand still under a fluorescent light.



Spin the wheel with the 60-mark strobe attached. Start timing when the strobe appears to stand still and time it until the wheel stops.



Top view, with the strobe wheel taped in place.

Record the times for several trials. Then, repeat for the 30-mark strobe.

	time				
	trial 1	trial 2	trial 3	trial 4	average
60-mark strobe					
30-mark strobe					

Summary question:

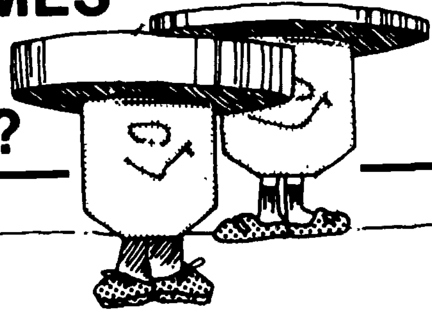
Does the 30-mark strobe go twice as fast as the 60-mark strobe?

OTHER IDEAS TO EXPLORE:

Would you get the same results if the speeds of the strobe wheels were one and two rpms? Three and six rpms?

Which method is more useful to store energy: high speed flywheels or heavy ones?

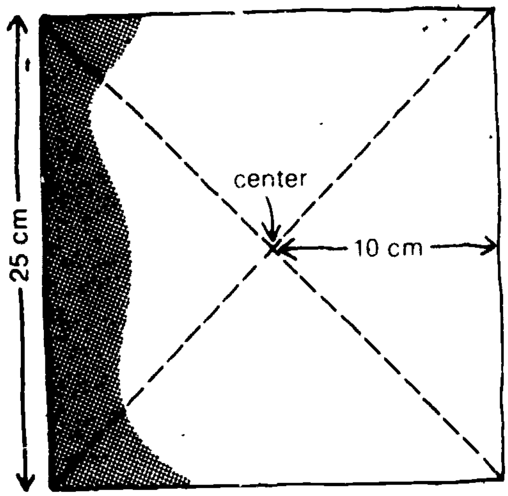
WILL A FLYWHEEL MADE OF ¾" PLYWOOD SPIN 3 TIMES LONGER THAN ONE MADE OF ¼" PLYWOOD?



8

MATERIALS:

Teacher's Discretion ¼" Drill, 1 piece ¾" plywood, 25-cm square
Flywheel from **Energy Storage, Activity 7**; tape
Teacher's Discretion Coping saw or jigsaw; watch with a second hand
Fluorescent light



First, drill a ¼" hole in the center of the ¾" plywood square.

Then cut a 20-cm diameter circle from the plywood.

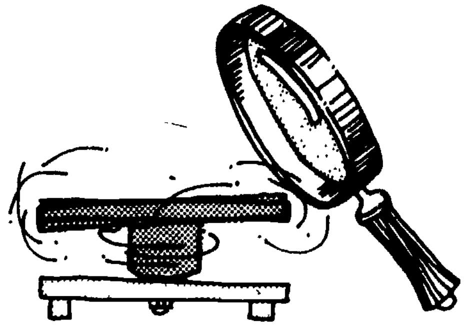
Set up your experiment using the ¼" plywood flywheel from **Energy Storage, Activity 7**. Spin the ¼" wheel. Watch for the stationary strobe pattern as it slows and start timing. Stop timing when the wheel stops. Try this several times and record your results.

Replace the flywheel with the one made of ¾" plywood. Use the same strobe wheel. Repeat the experiment several times, recording your results.

		flywheels	
		¾" plywood	¼" plywood
time	trial 1		
	trial 2		
	trial 3		
	trial 4		

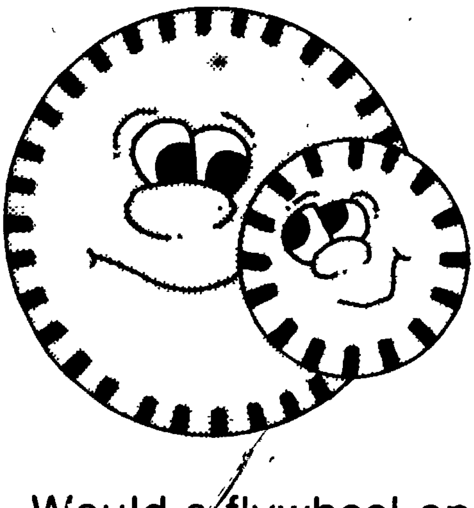
Summary questions:

Did the 3/4" plywood flywheel spin longer than the 1/4" plywood flywheel? How can you describe what you observed?



OTHER IDEAS TO EXPLORE:

How fast is the flywheel going when the strobe wheel appears to stand still?



Will a flywheel with a 12.5-cm diameter store half as much energy as a flywheel with a 25-cm diameter? Why?

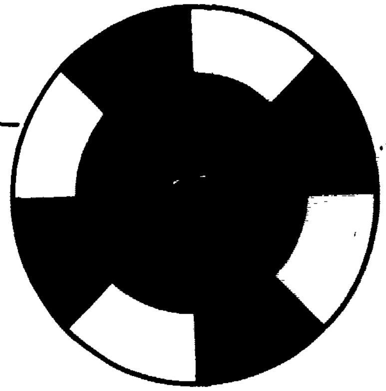
Will a 25-cm diameter flywheel made of lightweight material spin as long as one made of steel? Why?

Would a flywheel operate in a zero-gravity situation (e.g. a spaceship)? Would the weight of the flywheel make any difference?

THE GREAT FLYWHEEL CONTEST 9

MATERIALS:

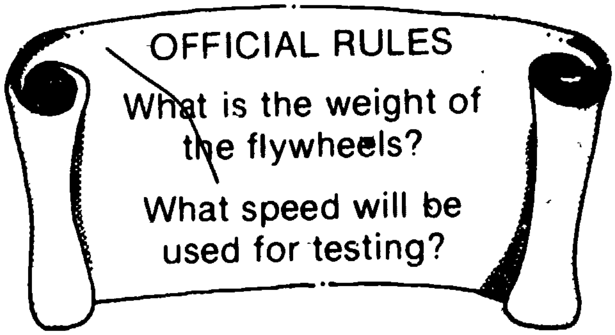
See **Energy Storage**, **Activities 7** and **8** for basic flywheel instructions
Odds and ends of wood, cardboard, etc.
Glue; tape; metric scale



Each student should make a flywheel which does not exceed an agreed upon weight. All flywheel testing should be done at an agreed upon speed.

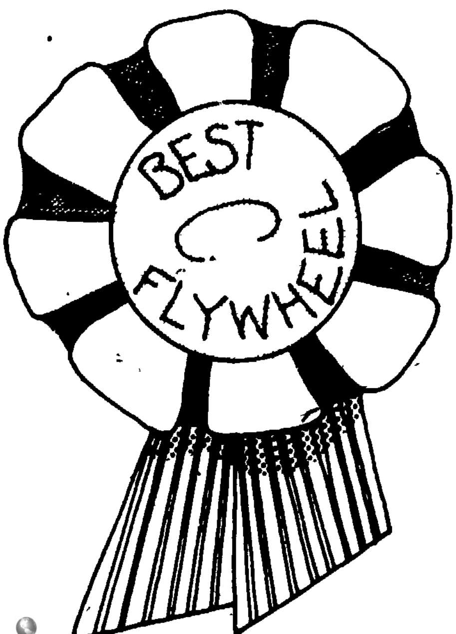
The wheel that spins the longest time is the winner.

Award a badge to the winning flywheel!



Summary question:

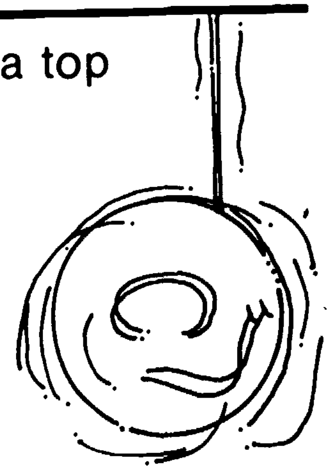
What is special about the winning flywheel?



OTHER IDEAS TO EXPLORE:

How would you design a top to make it a long spinner?

What is the connection between a gyroscope and a yoyo?

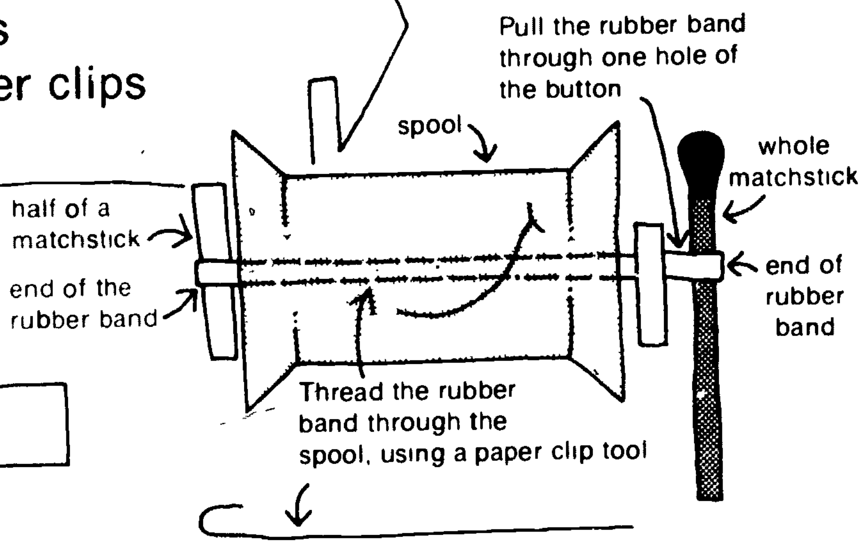


WILL A SPOOL GO TWICE AS FAR IF ITS RUBBER BAND MOTOR HAS TWICE AS MANY TURNS? 10

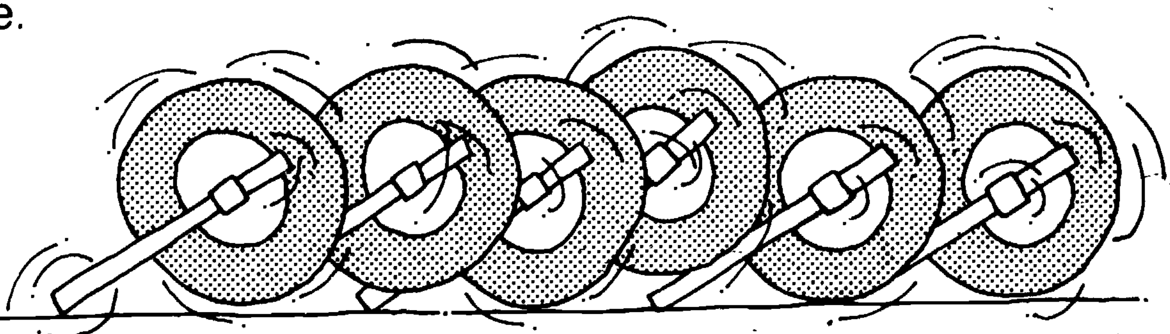
MATERIALS:

- #50 Thread spool (no thread)
- Button (large holes are best)
- Teacher's Discretion: Wooden matches
- Metric ruler; paper clips
- Rubber bands

"Motorize" your spool like this.

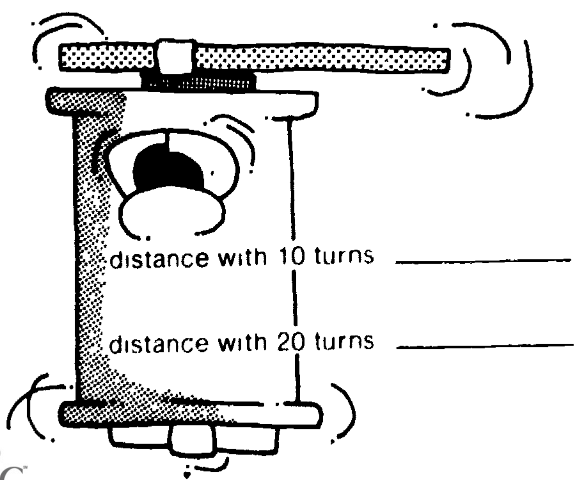


Then, wind the rubber band 10 turns and place the spool on a level surface.



Measure the distance it travels.

Repeat the experiment, winding the rubber band 20 times.

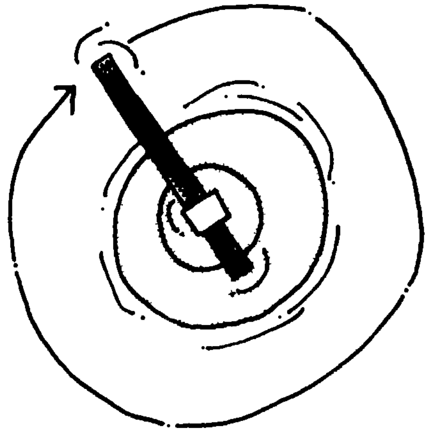


Summary question:

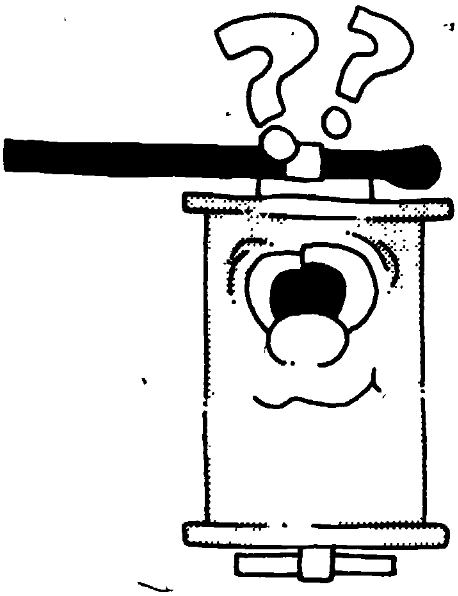
Does the spool go twice as far with 20 turns?

OTHER IDEAS TO EXPLORE:

How many turns of stored power are actually used to move the spool?



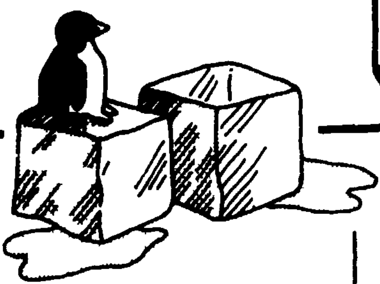
Wind the rubber band motor and store it overnight. How far does the spool go now? Does the energy in the rubber band keep well overnight?



How could you make the spool go farther without changing the rubber band or the number of turns?

HOW HOT WILL A MIXTURE OF WATER AND ICE GET WHEN IT'S HEATED?

11



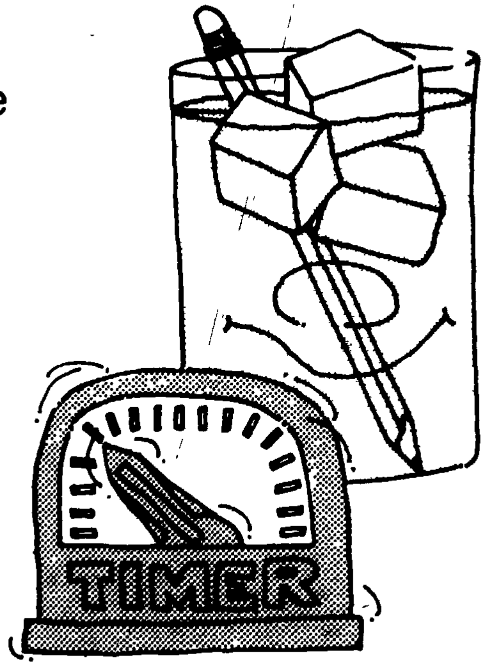
MATERIALS:

Soup can (empty)
Water; ice cubes; wooden pencil
Centigrade thermometer; graph paper; coat hanger
Candle or heat source; watch with a second hand

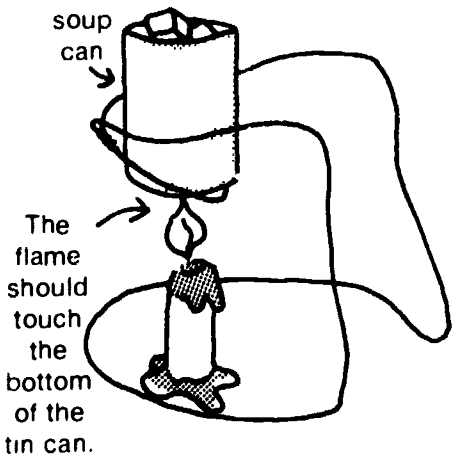
Bend the coat hanger to make a frame for the soup can. Place the soup can in the coat hanger frame.

Fill it three-fourths full of water and record the water temperature. Place a candle under the can and light it.

Add three ice cubes and wait three minutes. Place the thermometer in the can. Stir gently with the wooden pencil for 30 seconds, then read and record the temperature in the "START" space on the table.



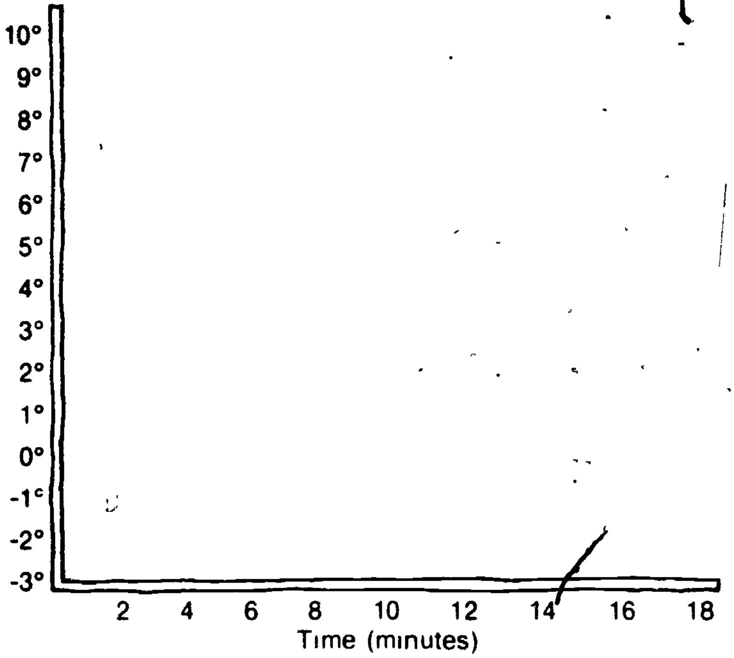
		Temperature*
	water temperature, no ice	
Time	START	
	2 min	
	4 min	
	6 min	
	8 min	
	10 min	
	12 min.	
	14 min.	
	16 min.	
	18 min	



Read and record the temperature every two minutes.

Make sure there are three cubes in the can at all times.

*Stir the water gently with the wooden pencil before each reading!



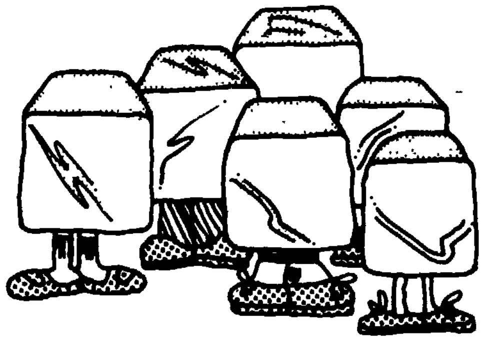
Graph the temperature data you recorded.

Summary questions:

How hot did the mixture get? Can you explain your temperature graph?

OTHER IDEAS TO EXPLORE:

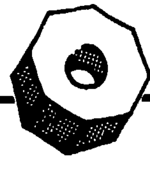
What will happen if you repeat the experiment but add twice as much ice?



What will happen if you repeat the experiment with two candles? with three candles?

WILL DROPPING A WEIGHT FROM 2 METERS PRODUCE TWICE THE DENT AS DROPPING IT FROM 1 METER?

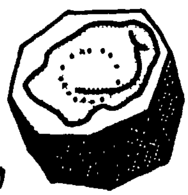
12



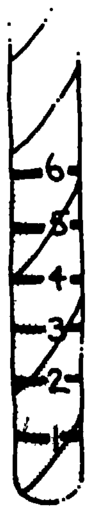
MATERIALS:

Metric ruler; masking tape; bucket; felt pen
Plastic drinking straw; modeling clay; bar magnet
Damp sand; large hex nut (or 50-gram weight from a balance scale)

Make a weight. Fill the center of the hex nut with modeling clay.



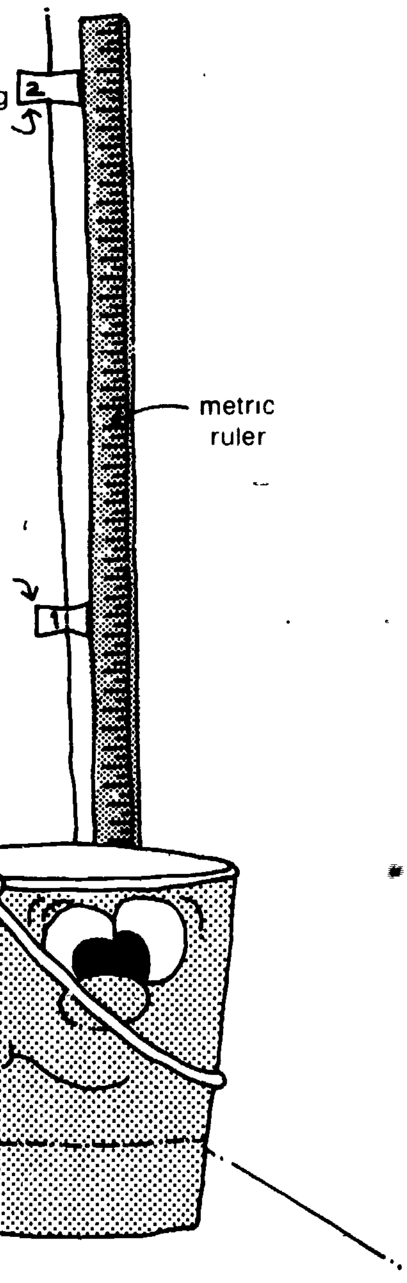
Make a measuring device. Mark off 1-cm units on the plastic drinking straw.



Pour damp sand in the bucket. Level the sand at 6-cm high. Place the bucket on the floor near a wall.

Measuring from the top of the sand, make a one-meter and two-meter mark on the wall with masking tape.

Hold the weight at the one-meter mark. Drop it into the center of the damp sand.



Remove the weight with the bar magnet. Measure the depth of the dent with the straw. Record the depth on your chart.

height	trial #	depth of dent	average depth
1 m	1		
	2		
	3		
2 m	1		
	2		
	3		

Smooth the sand, leveling it to 6-cm high. Drop the weight two more times from the one-meter mark, leveling the sand and recording the depth each time.

Now drop the weight from the two-meter mark. Repeat two more times to get an average.

Summary question:

Was the two-meter dent twice as deep as the one-meter dent?

OTHER IDEAS TO EXPLORE:

Repeat the experiment, substituting other weights. What materials could you use to replace the sand?

Would a pointed weight behave in the same manner as a blunt weight?

Would a weight dropped from three meters make a dent three times as deep as a weight dropped from one meter?

Science Activities in Energy was developed by Oak Ridge Associated Universities under contract with the U.S. Department of Energy. Mr. Mauri Gould, with the assistance of Ms. Marilyn Schuette and Memphis State University faculty Dr. Ron Cleminson and Dr. John Thompson, directed the development of the series.

Copies of *Science Activities in Energy* can be obtained by writing:
U.S. Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

Prepared by: Oak Ridge Associated Universities,
Oak Ridge, TN 37830, under Contract No. DE-AC05-76OR00033.

Prepared for: U.S. Department of Energy
Office of Energy Research, Washington, D.C. 20585

DOE/NBB-0003